

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

INVENTORS: Kazutaka HABU; Naoko TAKEDA

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TITLE: **"METHOD TO MANUFACTURE LEAD-FREE SOLDER MATERIAL HAVING GOOD WETTABILITY"** (*as amended*)

PRELIMINARY AMENDMENT "A" TO DIVISIONAL

BOX Patent Application
Assistant Commissioner for Patents
Washington, D.C. 20231

SIR:

This is a preliminary amendment to the 37 CFR 1.53(b) Divisional filed on

February 8, 2002.

IN THE TITLE

Please amend the title of the invention to read --METHOD TO MANUFACTURE

5 LEAD-FREE SOLDER MATERIAL HAVING GOOD WETTABILITY--.

IN THE SPECIFICATION

On page 1, between lines 2 and 3, please insert the following paragraph:

---RELATED APPLICATION DATA

This application claims priority to Japanese Application No. P09-348212, filed

10 December 17, 1997, and is a divisional of United States Application Serial No. 09/066,851, filed April 28, 1998, each of which is incorporated herein by reference to the extent permitted by law.--

IN THE CLAIMS

Please cancel claims 1-4 in favor of new claims 5-44. Please add new claims 5-44 as

15 follows:

- 100% RECYCLED PAPER
5. (New) A method to manufacture a lead-free Sn-Zn-Bi-Ge-Cu solder material, the
method comprising:
- presenting a Sn-Zn-Bi alloy;
- adding both Ge and Cu having Cu mixture wt.% to the Sn-Zn-Bi alloy so that Cu
5 coexists with Ge in a resulting mixture to facilitate uptake of Ge in a molten composition; and
- forming the molten composition from the resulting mixture,
wherein the Ge in the molten composition defines a predetermined Ge molten
composition wt.%, wherein the Cu mixture wt.% is a function of the predetermined Ge
molten composition wt.%, and wherein the molten composition exhibits good wettability as a
10 whole.
6. (New) The method of claim 5, wherein adding both Ge and Cu to the Sn-Zn-Bi
alloy consists of adding both Ge and Cu to the Sn-Zn-Bi alloy to shorten a zero cross time Tb.
- 15 7. (New) The method of claim 5, wherein adding Ge to the Sn-Zn-Bi alloy and adding
Cu to the Sn-Zn-Bi alloy comprise simultaneously adding Ge and CU to the Sn-Zn-Bi alloy
prior to beginning the formation of the molten composition.
- 20 8. (New) The method of claim 5, wherein the Sn-Zn-Bi-Ge-Cu composition
approximately contains 0.5 to 10 wt.% of Zn, 0.5 to 8 wt.% of Bi, 0.005 to 0.05 wt.% of Ge,
and 0.3 to 3 wt.% of Cu, with the balance being substantially Sn.
- 25 9. (New) The method of claim 8, further comprising:
measuring a molten solder sample of the Sn-Zn-Bi-Ge-Cu composition to verify that
the Sn-Zn-Bi-Ge-Cu composition approximately contains 0.5 to 10 wt.% of Zn, 0.5 to 8 wt.%

of Bi, 0.005 to 0.05 wt.% of Ge, and 0.3 to 3 wt.% of Cu, with the balance being substantially Sn.

10. (New) The method of claim 9, wherein measuring the molten solder sample
5 comprises employing Inductively Coupled Plasma Atomic Emission Spectrometer analysis.

11. (New) The method of claim 8, wherein the Sn-Zn-Bi-Ge-Cu composition consists of 0.5 to 5 wt.% of Zn.

10 12. (New) The method of claim 8, wherein the Sn-Zn-Bi-Ge-Cu composition consists of 5 to 8 wt.% of Bi.

15 13. (New) The method of claim 8, wherein the Sn-Zn-Bi-Ge-Cu composition consists of less than 80% of Sn.

14. (New) The method of claim 8, wherein the Sn-Zn-Bi-Ge-Cu composition consists of greater than 93.5% of Sn.

15 15. (New) The method of claim 5, wherein the Cu is added in a Cu mixture wt.% that
20 is insufficient to form an intermetallic compound of Cu and Sn.

16. (New) The method of claim 15, wherein the Sn-Zn-Bi-Ge-Cu composition
consists of 1 to 3 wt.% of Cu.

17. (New) The method of claim 5, wherein forming the molten composition comprises maintaining the resulting mixture in a melted state at about 400 degrees Celsius for about two to three hours, the method further comprising:

cooling the molten composition to form a solder ingot; and

5 measuring the solder ingot by employing Inductively Coupled Plasma Atomic Emission Spectrometer analysis to obtain the composition of the solder ingot.

18. (New) The method of claim 5, wherein the molten composition exhibits good wettability as a whole by exhibiting a short zero cross time Tb and a steep rising gradient for
10 a somewhat poor wet force F₂.

19. (New) A method to manufacture a lead-free Sn-Bi-Ag-Ge-Cu solder material, the method comprising:

presenting a Sn-Bi-Ag alloy;

15 adding both Ge and Cu having Cu mixture wt.% to the Sn-Bi-Ag alloy so that Cu coexists with Ge in a resulting mixture to facilitate uptake of Ge in a molten composition; and forming the molten composition from the resulting mixture,

wherein the Ge in the molten composition defines a predetermined Ge molten
composition wt.%, wherein the Cu mixture wt.% is a function of the predetermined Ge
20 molten composition wt.%, and wherein the molten composition exhibits good wettability as a
whole.

20. (New) The method of claim 19, wherein adding both Ge and Cu to the Sn-Bi-Ag

alloy consists of adding both Ge and Cu to the Sn-Bi-Ag alloy to shorten a zero cross time

25 Tb.

21. (New) The method of claim 19, wherein adding Ge to the Sn-Bi-Ag alloy and adding Cu to the Sn-Bi-Ag alloy comprise simultaneously adding Ge and Cu to the Sn-Bi-Ag alloy prior to beginning the formation of the molten composition.

5 22. (New) The method of claim 19, wherein the Sn-Bi-Ag-Ge-Cu composition approximately contains 0.5 to 8 wt.% of Bi, 0.5 to 3 wt.% of Ag, 0.01 to 0.1 wt.% of Ge, 0.3 to 1 wt.% of Cu, with the balance being substantially Sn.

10 23. (New) The method of claim 22, further comprising:

measuring a molten solder sample of the Sn-Bi-Ag-Ge-Cu composition to verify that the Sn-Bi-Ag-Ge-Cu composition approximately 0.5 to 8 wt.% of Bi, 0.5 to 3 wt.% of Ag, 0.01 to 0.1 wt.% of Ge, 0.3 to 1 wt.% of Cu, with the balance being substantially Sn.

15 24. (New) The method of claim 23, wherein measuring the molten solder sample

comprises employing Inductively Coupled Plasma Atomic Emission Spectrometer analysis.

20 25. (New) The method of claim 22, wherein the Sn-Bi-Ag-Ge-Cu composition

consists of 0.5 wt.% of Bi.

26. (New) The method of claim 22, wherein the Sn-Bi-Ag-Ge-Cu composition

consists of not more than 0.4 wt.% of Cu.

27. (New) The method of claim 19, wherein the Cu is added in a Cu mixture wt.%

that is insufficient to form an intermetallic compound of Cu and Sn.

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28. (New) The method of claim 27, wherein the Sn-Bi-Ag-Ge-Cu composition
consists of not more than 0.4 wt.% of Cu.
29. (New) The method of claim 27, wherein the Sn-Bi-Ag-Ge-Cu composition
5 consists of 0.3 to 0.4 wt.% of Cu.
30. (New) The method of claim 19, wherein forming the molten composition
comprises maintaining the resulting mixture in a melted state at about 400 degrees Celsius for
about two to three hours, the method further comprising:
10 cooling the molten composition to form a solder ingot; and
measuring the solder ingot by employing Inductively Coupled Plasma Atomic
Emission Spectrometer analysis to obtain the composition of the solder ingot.
31. (New) The method of claim 19, wherein the molten composition exhibits good
wettability as a whole by exhibiting a short zero cross time Tb and a steep rising gradient for
a large wet force F₂.
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32. (New) A method to manufacture a lead-free Sn-Zn-In-Ge-Ag solder material, the
method comprising:
20 presenting a Sn-Zn-In alloy;
adding both Ge and Ag having Ag mixture wt.% to the Sn-Zn-In alloy so that Ag
coexists with Ge in a resulting mixture to facilitate uptake of Ge in a molten composition; and
forming the molten composition from the resulting mixture,
wherein the Ge in the molten composition defines a predetermined Ge molten
25 composition wt.%, wherein the Ag mixture wt.% is a function of the predetermined Ge

molten composition wt.%, and wherein the molten composition exhibits good wettability as a whole.

33. (New) The method of claim 32, wherein adding both Ge and Ag to the Sn-Zn-In
5 alloy consists of adding both Ge and Ag to the Sn-Zn-In alloy to shorten a zero cross time Tb.

34. (New) The method of claim 32, wherein adding Ge to the Sn-Zn-In alloy and adding Ag to the Sn-Zn-In alloy comprise simultaneously adding Ge and AG to the Sn-Zn-In alloy prior to beginning the formation of the molten composition.

10 35. (New) The method of claim 32, wherein the Sn-Zn-In-Ge-Ag composition
approximately contains 3 to 15 wt.% of Zn, 3 to 10 wt.% of In, 0.01 to 0.3 wt.% of Ge, and
0.3 to 3 wt.% of Ag, with the balance being substantially Sn.

15 36. (New) The method of claim 35, further comprising:
measuring a molten solder sample of the Sn-Zn-In-Ge-Ag composition to verify that
the Sn-Zn-In-Ge-Ag composition approximately contains 3 to 15 wt.% of Zn, 3 to 10 wt.% of
In, 0.01 to 0.3 wt.% of Ge, and 0.3 to 3 wt.% of Ag, with the balance being substantially Sn.

20 37. (New) The method of claim 36, wherein measuring the molten solder sample
comprises employing Inductively Coupled Plasma Atomic Emission Spectrometer analysis.

25 38. (New) The method of claim 35, wherein the Sn-Zn-In-Ge-Ag composition consists
of 3 to 5 wt.% of Zn.

39. (New) The method of claim 35, wherein the Sn-Zn-In-Ge-Ag composition consists

of 3 wt.% of In.

40. (New) The method of claim 35, wherein the Sn-Zn-In-Ge-Ag composition consists

5 of .3 wt.% of Ag.

41. (New) The method of claim 32, wherein the Ag is added in an Ag mixture wt.%

that is insufficient to form an intermetallic compound of Ag and Sn.

10 42. (New) The method of claim 41, wherein the Sn-Zn-In-Ge-Ag composition consists

of .3 wt.% of Ag.

43. (New) The method of claim 32, wherein forming the molten composition

comprises maintaining the resulting mixture in a melted state at about 400 degrees Celsius for

15 about two to three hours, the method further comprising:

cooling the molten composition to form a solder ingot; and

measuring the solder ingot by employing Inductively Coupled Plasma Atomic

Emission Spectrometer analysis to obtain the composition of the solder ingot.

20 44. (New) The method of claim 32, wherein the molten composition exhibits good

wettability as a whole by exhibiting a short zero cross time Tb and a steep rising gradient for

a somewhat poor wet force F₂.

REMARKS

Claims 1-4 were pending and under consideration. Claims 1-4 were canceled in favor of new claims 5-44. Claims 5-44 were added. Claims 5-44 now are pending and under consideration.

Respectfully submitted,
SONNENSCHEIN NATH & ROSENTHAL
Attorneys for Applicant

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by: 
David R. Metzger
Reg. No. 32,919

SONNENSCHEIN NATH & ROSENTHAL P.O. Box 061080 Wacker Drive Station, Sears Tower Chicago, IL 60606-1080	CERTIFICATE OF MAILING I hereby certify that this correspondence is being deposited with the U.S. Express Mail "EL834555227 US" in an envelope addressed to: BOX Patent Application, Assistant Commissioner for Patents, Washington, D.C. 20231 on February 8, 2002.  Rose M. Garza Date: February 8, 2002
Attorney Customer Number: 026263 Phn: (312) 876-8000 Fax: (312) 876-7934	